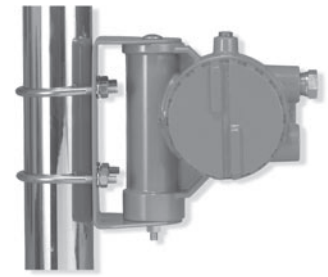
February 2006

RegFlo™ RF100 Series Pressure and Flow Instruments



W8196

TYPE RF110 PRESSURE INSTRUMENT

W8379

TYPE RF100 FLOW AND PRESSURE INSTRUMENT MOUNTED ON A TYPE 1098-EGR REGULATOR

W8162

TYPE RF100 FLOW AND PRESSURE INSTRUMENT MOUNTED ON TYPE EZR REGULATOR

Benefits

- Data Archive
- Flow Estimation
- Pressure Recorder
- User Level Security
- Economical Flow Data
- Low Power Consumption
- Host and Local Communications
- Type EZR or 1098-EGR Retrofit Capability

New and Improved

- New Algorithms
- Improved Modem
- Inches w.c. Sensor
- Extended Battery Life
- More Mountings Available
- Expanded History Capacity
- Metric Configuration Available
- One Second Sample Rate Available

D102790X012

US Patent Number 6441744
Other US and Foreign Patents Pending

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Introduction

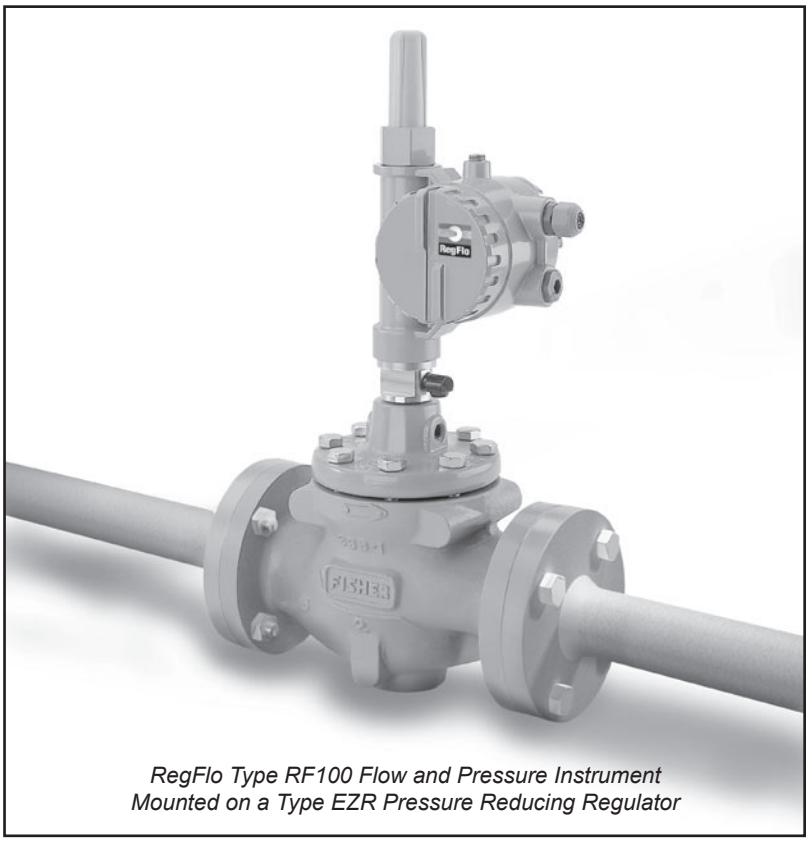
RegFlo™ RF100 Series pressure and flow instruments are devices which measure and archive flow and pressure data. Other parameters such as battery voltage, and minimum and maximum values are also stored. Alarms may be configured to signal abnormal or emergency conditions. The Type RF110 instrument is used as a stand-alone pressure instrument. Mounted on a regulator, such as the Type EZR or 1098-EGR, the Type RF100 instrument measures pressure and also estimates flow rates based on valve plug travel.

Features

• **Flow Estimation**—The RegFlo™ Type RF100 instrument estimates the flow rate through the regulator by measuring inlet pressure, outlet pressure and the valve plug travel of the Type EZR or 1098-EGR. The device stores these estimates in a time stamped history file. The accuracy is within ± 10% of actual flow.

• **Type EZR or 1098-EGR Retrofit Capability**—The Type RF100 instrument can be field mounted to the bonnet of an existing Type EZR or 1098-EGR regulator. The Type EZR or 1098-EGR travel indicator or indicator plug is replaced with the Type RF100 instrument assembly.

• **Low Power Consumption**—The RF100 Series electronics and firmware are designed for minimal power consumption. This allows the device to battery powered. External power may also be applied from a power supply or solar panel.



RegFlo Type RF100 Flow and Pressure Instrument Mounted on a Type EZR Pressure Reducing Regulator

• **Extended Battery Life**—Over 2 year battery life when set for one minute sample intervals and a five minute modem connection per day.

• **Configurable Sample and Log Intervals**—The RegFlo instrument may be configured to meet specific customer requirements. The Sample Interval sets the frequency for measurements. The Log Interval sets the rate of recording data to the history file.

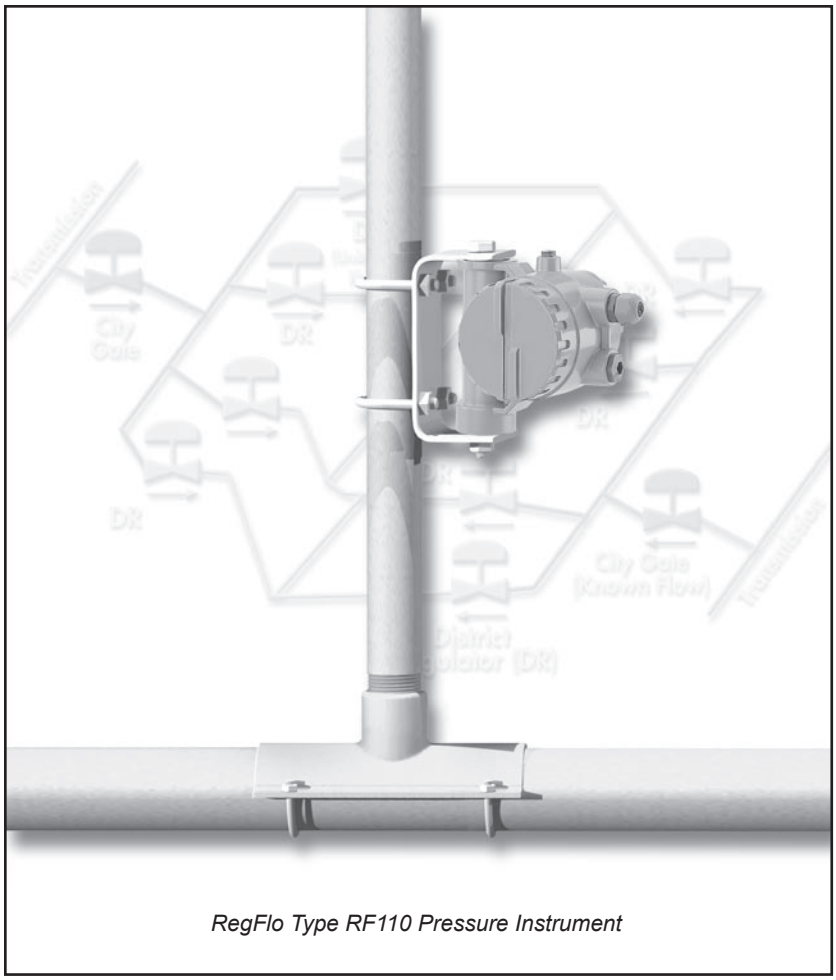
• **Data Archive**—RegFlo instruments record data in a daily log at a specified log interval. Average, minimum, and maximum values are recorded for the pressure and flow inputs. Other records for battery voltage and board temperature are also stored. The RegFlo instrument stores 35 days of daily records and 840 logs for the log interval rate.

• **Expanded History**— Additional file maintains 8640 logs for the log interval rate.

• **Low Pressure Sensor**—0 to 30-inches w.c. (0 to 75 mbar) range with accuracy of 1.5% of span.

• **User Level Security**—The RegFlo instrument allows the user to specify a user name, password, and access level for up to fifteen different users. The access level controls who is allowed access to menus and screens in the RegLink™ software.

• **Alarms**—Alarms can be configured in the RegFlo instrument to trigger abnormal conditions for each of the sampled parameters. High and low alarm conditions are available. Alarms are stored in the alarm log. The RegFlo instrument will store the last 240 alarm logs. Each alarm may also be set for Spontaneous Report by Exception.



RegFlo Type RF110 Pressure Instrument

Benefits

- **Easy Integration**— The data acquired by the RegFlo instrument can be easily integrated into existing Supervisory Control and Data Acquisition (SCADA) systems with the use of ROC or Modbus protocols.

- **Time Stamped Data**—Records regulator station parameters to help troubleshoot station performance problems.

- **Economical Flow Data**—No requirement for expensive metering equipment.

- **Verify and Calibrate Model**—Flow and pressure data from the RegFlo instrument can be used to verify and calibrate assumptions used to develop the model. Confidence in the model output is improved.

- **New Modem Communications**—Modem available to receive communications full time and maintain 27 month battery life.

- **Metric Units**—Instrument can be configured to record pressures in kPa or bar and flow in Nm^3/h.

- **Local Communications**—The RegFlo instrument includes a Local Operator Interface (LOI) port for interface to the RegLink™ software with a personal computer (PC).

- **Increased Sample Rate**—Selection provided for one second sample interval.

- **Logic Alarms**—Logic alarms provide a mechanism to link multiple parameters together in a single alarm. Travel, pressures, and flow conditions may be combined to trigger conditions such as shutoff problems or monitor override control.

- **Pressure Recorder**—The Type RF110 instrument is an Electronic Pressure Recorder. It can measure and record up to three different pressures.

- **Asset Management**—Better information contributes to greater system efficiency, productivity and optimization.

- **Comparison**—The data acquired can be used to compare customer demand on the system over certain time periods. Provides the ability to disclose areas that are at or near full capacity.

- **Defer Capital Expenditures**—The data provided by the RegFlo instrument may enable companies to reduce or delay major capital expenditures, such as pipeline construction.

- **Host Communications**—The RegFlo instrument supports two communication ports that can be used for host communications. These host ports support communication based on ROC and Modbus protocols.

- **Safety and Integrity**—Report by exception and other alarm capabilities help ensure the health of the system.

Specifications

Available Configurations

Type RF100: Flow and Pressure Instrument measures valve plug travel, inlet pressure, and outlet pressure when mounted on a Type EZR or 1098-EGR

Type RF110: Pressure Instrument is used as a stand-alone pressure recorder

Security

15 users with passwords and 3 levels of access

Alarms

- Hi, Hi/Hi, Low, and Low/Low, on all analog inputs
- Logic alarms
- 240 logs in alarm log

Sensor and Pressure Ranges[1]

See Table 1

Instantaneous Flow Estimation Accuracy

See Tables 2 and 3 and the Instantaneous Flow Estimation Accuracy section.

Log Interval

LOG INTERVAL, MINUTES	STANDARD HISTORY CAPACITY, DAYS (840 LOGS STORED, ALL VERSIONS)	EXTENDED HISTORY CAPACITY, DAYS (8640 LOGS STORED, AVAILABLE ONLY FOR FIRMWARE VERSION 2 AND HIGHER)
1	0.6	6
2	1.2	12
3	1.8	18
4	2.3	24
5	2.9	30
6	3.5	36
10	5.8	60
12	7.0	72
15	8.8	90
20	11.7	120
30	17.5	180
60	35.0	360

Daily Log

35 days of daily values (average, accum, min/max)

Sample Intervals

1, 10, and 30 seconds; 1, 2, 5, 10, and 30 minutes

Processor Memory

Flash: 128 Kbytes
EEProm: 32 Kbytes
Static RAM: 128 Kbytes

Power

Battery Input: 3.6 Vdc
Input Power: 10 to 28 Vdc

Battery Information

Lithium Ion, 3.6 Vdc, 19.0 amp-hours

Diagnostics

Board Temperature, Power Input, Logic/Battery Voltage

Real Time Clock

- Hr:Min:Sec
- Day:Month:Year
- Battery Backed

Communication Ports

Operator Interface: RS-232 (RX, TX, RTS); ROC protocol only
COM1: RS-485; ROC and Modbus protocol
COM2 (Optional): RS-232 or V-22 BIS Modem; ROC and Modbus protocol

Environmental[1]

Operating Temperature: -40° to 167°F (-40° to 75°C)
Storage Temperature: -58° to 185°F (-50° to 85°C)
Operating Humidity: 5% to 95% non-condensing
Vibration: Meets SAMA PMC 31.1
Electromagnetic Interference: Designed to meet requirements of IEC 61326 Electrical Equipment for Measurement, Control, and Laboratory Use
Radiated Emissions: FCC Part 15 Class A

Approvals

CSA Class I, Division 1, Explosion-Proof, Gas Groups C and D; Class I, Division 2, Nonincindive groups C and D; Certified to Canadian and U.S. Standards

Construction

Pressure Sensor Body: S31600 Stainless steel
Housing and Cap: Die-cast aluminum alloy with iridite plating and paint
Exposed Bar Parts: S31600 Stainless steel
Pipe Plug: Plated steel

Connections

Electrical: Housing has 2-1/2-inch 14 NPT conduit connections for wiring
Process: Sensors have 1/4-inch 18 NPT process connections
Vents: Vent connections are tapped with 1/4-inch 18 NPT threads for use with piping in pit installations

Weight

Type RF100: *1 or 2-inch (DN 25 or 50):* 7.8 pounds (3,54 kg)
3 or 4-inch (DN 80 or 100): 8.0 pounds (3,63 kg)
6-inch (DN 150): 9.0 pounds (4,08 kg)
Type RF110: 7.0 pounds (3,18 kg)

1. The pressure/temperature limits in this bulletin or any applicable standard limitation should not be exceeded.

Table 1. *Sensor and Pressure Ranges, and Accuracy*

SENSOR RANGE, PSIG (bar)	ACCURACY, % OF SPAN		MAXIMUM OPERATING PRESSURE, PSIG (bar)	MAXIMUM EMERGENCY PRESSURE, PSIG (bar)
	-4° to 122°F (-20° to 50°C)	-40° to 167°F (-40° to 75°C)		
0 to 30-inches w.c. (0 to 75 mbar)	1.5	2.5	9 (0,62)	300 (20,7)
0 to 15 (0 to 1,03)	0.5	1.0	45 (3,10)	475 (32,8)
0 to 35 (0 to 2,41)	0.5	1.0	85 (5,86)	475 (32,8)
0 to 100 (0 to 6,90)	0.5	1.0	185 (12,8)	475 (32,8)
0 to 300 (0 to 20,7)	0.5	1.0	585 (40,3)	1500 (103)
0 to 500 (0 to 34,5)	0.5	1.0	985 (67,9)	1500 (103)
0 to 1000 (0 to 68,9)	0.5	1.0	1500 (103)	1500 (103)
0 to 1500 (0 to 103)	0.5	1.0	1500 (103)	1500 (103)

Table 2. *Type 1098-EGR Instantaneous Flow Estimation Accuracy*

CAGE TYPE	PERCENTAGE OF ACTUAL FLOW				
	For 5 to 10% of Travel	For 10 to 20% of Travel	For 20 to 30% of Travel	For 30 to 40% of Travel	For 40 to 100% of Travel
Linear or Quick Opening	± 30	± 20	± 15	± 10	± 10
Whisper Trim®	± 20	± 17.5	± 15	± 10	± 7.5
Note: The accuracy of the flow estimation is dependant on pressure drop and pressure sensor range.					

Table 3. *Type EZR Instantaneous Flow Estimation Accuracy*

DIAPHRAGM MATERIAL	PERCENTAGE OF ACTUAL FLOW			
	2-Inch (DN 50)		3 and 4-Inch (DN 80 and 100)	
	For 20 to 30% of Maximum Flow	For 30 to 100% of Maximum Flow	For 20 to 30% of Maximum Flow	For 30 to 100% of Maximum Flow
17E97 Nitrile	±15	±10	±20	±10
17E67 Nitrile	±20	±15	±20	±15

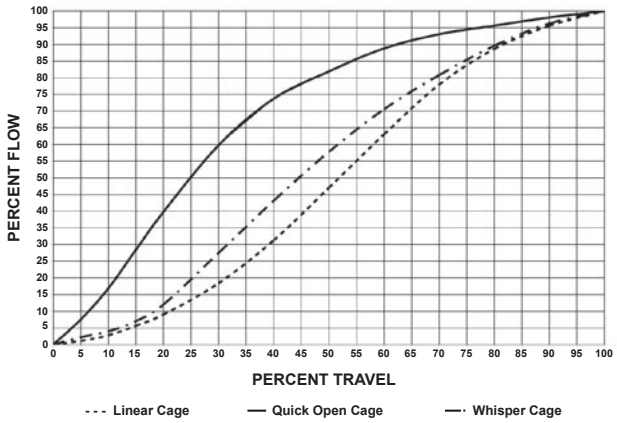


Figure 1. *Typical Flow Characteristic of the Type 1098-EGR*

Principle of Operation

The main function of RegFIo RF100 Series instruments is the acquisition and storage of pressure, travel, and flow data from the regulator installation. It also provides alarm and diagnostic functions relative to pressure, travel and flow.

The flow algorithm uses upstream and downstream pressure measurements along with travel to calculate an instant and accumulate flow rate. The travel and pressure sensors are integral to the module. It is also available with an optional third pressure sensor. The module may also be mounted remotely and used only to monitor line pressures.

Data storage will be provided in the unit. That data may be accessed via a local interface or remotely. The remote connection may be via dial-up phone or radio. The communications ports will support ROC and Modbus protocols. The unit is designed to meet Class 1 Division 1 explosion proof requirements and be submersible. It is DC powered by an internal battery or external source.

Type RF100 Flow and Pressure Instrument

The Type RF100 instrument measures valve plug travel, inlet pressure, and outlet pressure. A third pressure sensor is available as an option to measure an auxiliary pressure. An algorithm estimates the flow through the regulator and archives pressure, travel, and flow data in the history log. It also records other parameters such as battery output, minimums and maximum values, etc. Alarms may be configured to signal abnormal or emergency conditions.

The Type RF100 flow and pressure instrument is available for the 1, 2, 3, 4, and 6-inch (DN 25, 50, 80, 100, and 150) Type EZR and the 2, 3, 4, and 6-inch (DN 50, 80, 100, and 150) Type 1098-EGR body sizes. The flow estimation is not available for the 1-inch (DN 25) Type EZR. It is also not available for the 6-inch (DN 150) Type EZR when the differential pressure exceeds 175 psi (12,1 bar).

Type RF100 Pressure and Travel Indication

The Type RF100 instrument is available for the 1, 3, and 6-inch (DN 25, 80, and 150) Type EZR body sizes as a pressure and travel indicator. The instantaneous flow estimation capability for these sizes is currently not available. Instantaneous flow estimation capability will be added when development of the required Flow Estimation Algorithm is completed. A field installable software update will be available to add the Flow Estimation Algorithm. The unit will not have to be removed from its installation to install the update. Until the software update is installed, the instrument will display the value of zero for the Estimated Flow, Accumulated Flow, and Accumulated Travel values.

Instantaneous Flow Estimation Accuracy

Type EZR

The instantaneous flow estimation accuracy of the RegFlo Type RF100 instrument is related to the percentage of flow through the Type EZR regulator. As the flow rate through the regulator increases, the instrument's flow estimation becomes more accurate. The typical flow estimation accuracy for each Type EZR body size is shown in Table 3.

Note

The percent of flow is not equivalent to percent of travel. The Type EZR regulator does not exhibit a linear valve characteristic. The regulator in most cases will not start to flow through the main valve until the percentage of travel reaches 10% of full open. Refer to the Type EZR Bulletin, 71.2:EZR (D102626X012) capacity tables for the maximum flow of the regulator. The maximum flow is related to inlet pressure and outlet pressure of the regulator.

Field data shows that the RegFlo Type RF100 has the ability to estimate hourly flow rates within ± 5% of the actual flow and daily rates within ± 2% of the actual when the Type EZR regulator is operating at or above mid-range of capacity.

Type 1098-EGR

The instantaneous flow estimation accuracy of the RegFlo Type RF100 instrument is related to the percentage of travel through the Type 1098-EGR regulator. As the flow rate through the regulator increases, the instrument's flow estimation becomes more accurate. The typical flow estimation accuracy for each Type 1098-EGR cage is shown in Table 2.

The accuracy is improved at higher pressure drops. The data in Table 3 is representative of a 5 to 10 psi (0,34 to 0,69 bar) pressure drop. Accuracy of the pressure sensor at lower pressure drops also has an impact.

The relationship of flow to travel is dependent on the main valve cage type used. Figure 1 shows the typical characteristic (flow vs. travel) for each cage type.

Type RF110 Pressure Instrument

The Type RF110 instrument is used as a stand-alone pressure recorder. It is the same as the Type RF100 instrument except it is mounted remotely from the regulator and does not measure regulator travel or estimate flow rates. Pressures are piped to the unit and are measured and archived in the history log. Other parameters such as battery output, and minimum and maximum values are also stored. Alarms may be configured to signal abnormal or emergency conditions.

Configuration Parameters

Sample Interval

The Sample Interval is how often a sample is taken of Analog Input values. The RegFlo instrument electronics will go into a low power mode between samples. This allows the power consumption to be minimized. The more frequently the RegFlo instrument samples the Analog Inputs the more power is consumed, or the shorter the battery life. The default Sample Interval is 1 minute. See Table 3 to determine power requirements for the device. The following selections for Sample Interval are provided:

- 1 second
- 10 second
- 30 second
- 1 minute
- 2 minute
- 5 minute
- 10 minute
- 30 minute

Periodic Log Interval

The Log Interval is the rate sampled values are logged to the History log. For example, if a 60 minute Log Interval is selected, the History log will include a log record for every 60 minute interval. The selection of Log Intervals influences the memory capacity of the History log. The History log will store 840 of the most current records. See the Specifications section on page 4 for further information. The following selections for the Periodic Log Interval are provided:

- 1 minute
- 2 minute
- 10 minute
- 12 minute

- 3 minute
- 4 minute
- 5 minute
- 6 minute
- 15 minute
- 20 minute
- 30 minute
- 60 minute

Log intervals for the Extended History log include the above plus 10, 20, and 30 seconds.

Regulator Parameters (Type RF100 only)

The flow calculation requires the user to configure parameters relative to the regulator type, size, material, and construction. Other parameters, such as specific gravity and temperature of the gas must also be specified. The user has the option to use a different temperature for each month of the year.

The user may also configure the type of regulator installation. The Installation Type is used for setting the default Logic Alarms. The Installation Types are defined in the following paragraphs:

Single Cut (2 or 3 sensors)—Refer to Figure 2A on page 8. The Type RF100 instrument is installed on a single pressure cut and the unit is measuring the inlet and outlet pressure of the regulator. An optional third pressure sensor could measure another pressure at the installation.

Downstream RegFlo Instrument (2 sensors)—Refer to Figures 2B and 2C on page 8. In an Upstream Wide-Open System it is recommended that the Type RF100 instrument be installed on the working (downstream) regulator. In a Working Monitoring System the Type RF100 instrument may be installed on either regulator. In this type, it is installed on the downstream regulator. The inlet pressure (P_1) sensor is monitoring the pressure between the two regulators (intermediate pressure) and the outlet pressure sensor (P_2) is monitoring the station outlet pressure.

Downstream RegFlo Instrument (3 sensors)—This is the same as the Downstream RegFlo Instrument (2 sensors) with the additional auxiliary (P_3) sensor monitoring the station inlet pressure.

Table 4. *Modbus Register Assignments*

MODBUS REGISTER	AI NUMBER	DESCRIPTION
7001	A1	P_1 inlet pressure
7002	A2	P_2 outlet pressure
7003	A3	P_3 auxiliary pressure
7004	A4	Travel
7005	A5	Instantaneous flow
7006	A6	Accumulated flow
7007	A7	Barometric pressure
7008	A8	Input voltage
7009	A9	Board temperature
7010	A10	Logic (battery) voltage

Upstream RegFlo Instrument (3 sensors)—Refer to Figures 2D and 2E on page 9. In an Downstream Wide-Open System it is recommended that the Type RF100 instrument be installed on the working (upstream) regulator. In a Working Monitoring System the Type RF100 instrument may be installed on either regulator. In this type, it is installed on the upstream regulator. The inlet pressure (P_1) sensor is monitoring the station inlet pressure and the outlet pressure sensor (P_2) is monitoring the pressure between the two regulators (intermediate pressure.) The auxiliary (P_3) sensor is monitoring the station outlet pressure.

Custom—Any other installation type not defined above. This selection will clear all of the default Logic Alarms.

Communication Ports

The RegFlo instrument communication ports provide a data link to the RegLink software and host systems. Available Comm Ports are as follows:

- Local Operator Interface (LOI)—EIA-232 for use with RegLink (Standard)
- COM1 (Host)—EIA-485 Serial Communications (Standard)
- COM2 (Host)—Dial up modem or EIA-232 Serial Communications (Optional)

The Local Operator Interface port supports Fisher ROC protocol. The Host ports support Fisher ROC and Modbus protocols on the same channel. Refer to the RegLink™ Software User Manual (Form 5669, PN D102780X012) for further information.

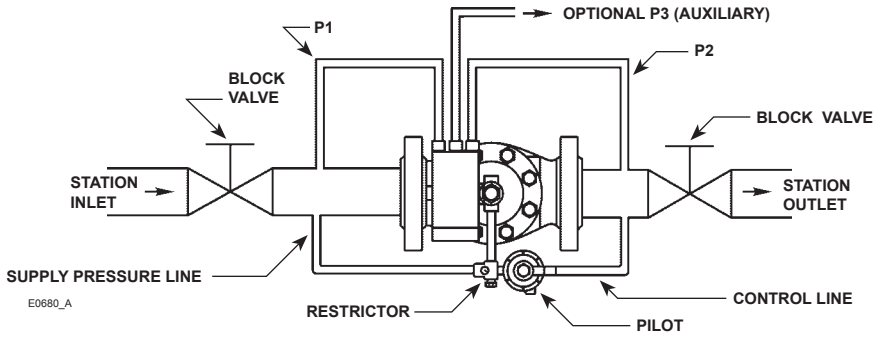
The COM2 host port supports Spontaneous Report by Exception (RBX). This allows the RegFlo instrument to call-in to a host computer when an alarm occurs.

Modbus Configuration

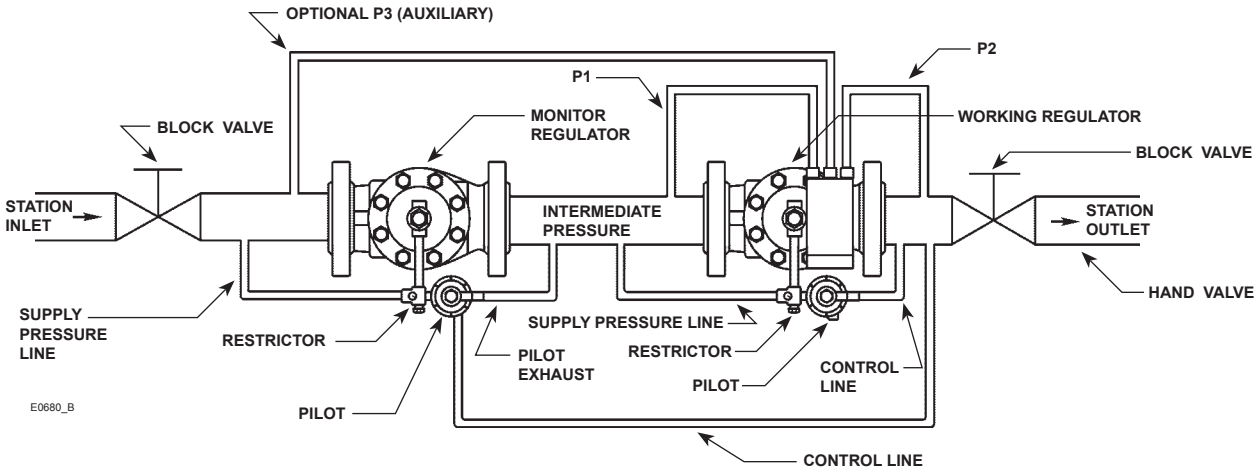
The RegFlo instrument supports Modbus Function Codes 3 and 16 over communications ports COM1 and COM2. All RegFlo values are read or written as Floating-point values. See Table 4 for the default assignments and descriptions for Function Code 3. For further details of the Modbus functionality, refer to the RegLink Software User Manual (Form 5669, D102780X012), September 2005.

Alarms

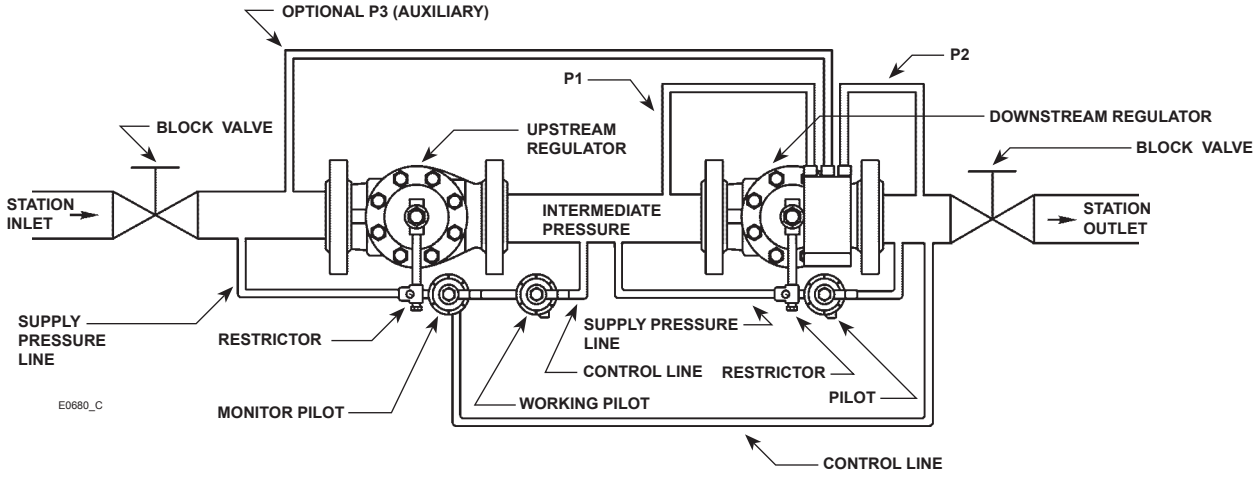
Alarms may be set for each of the Analog Inputs (listed below). High, Low, Hi/Hi, and Lo/Lo alarms are available. Each Analog Input alarm may also be set for RBX alarming. A record of the alarms is stored in the Alarm Log. The Alarm Log stores 240 of the latest alarms.



***2A**—Single Regulator Installation with 2 or 3 Pressure Sensors Used in the RF100 Series [Installation Type: Single Cut (Two or Three Sensors)]*

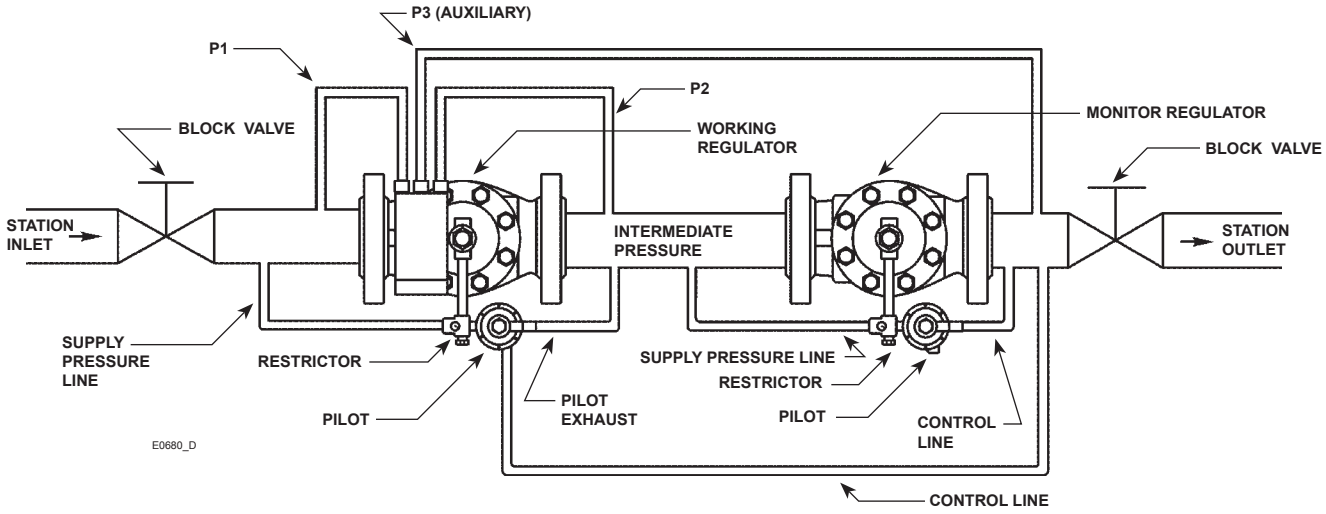


***2B**—Upstream Wide-Open Monitoring System Installation with 2 or 3 Pressure Sensors Used in the Type RF100 [Installation Type: Downstream RegFlo™ (Two or Three Sensors)]*

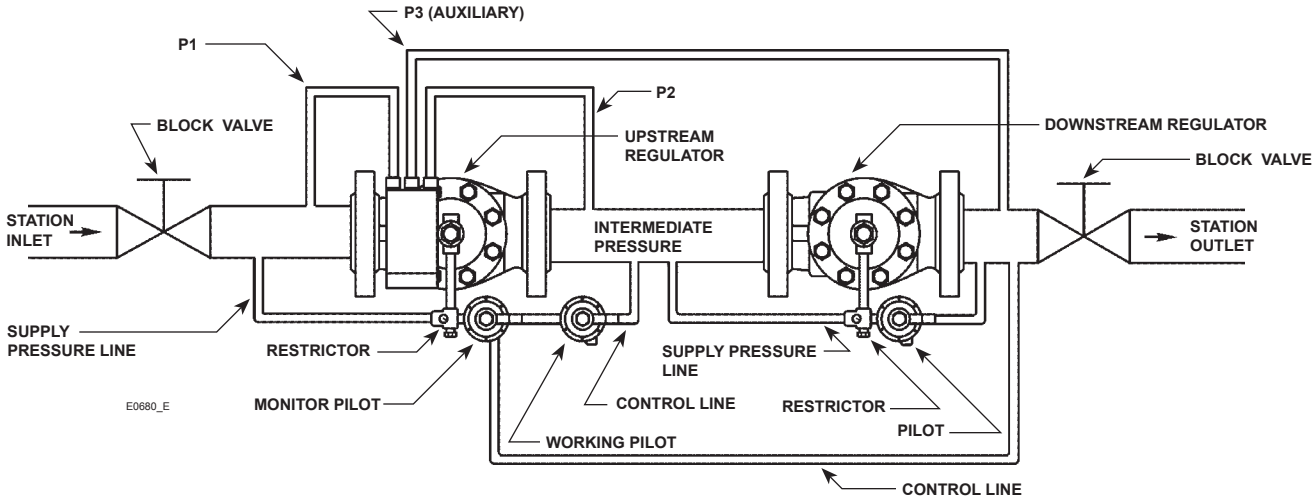


***2C**—Working Monitoring System Installation with 2 or 3 Pressure Sensors Used in the Type RF100 [Installation Type: Downstream RegFlo™ (Two or Three Sensors)]*

***Figure 2.** RF100 Series Typical Installations*



***2D**—Downstream Wide-Open Monitoring System Installation with 3 Pressure Sensors Used in the Type RF100 [Installation Type: Upstream RegFlo™ (Three Sensors)]*



***2E**—Working Monitoring System Installation with 3 Pressure Sensors Used in the Type RF100 [Installation Type: Upstream RegFlo™ (Three Sensors)]*

***Figure 2.** RF100 Series Typical Installations (continued)*

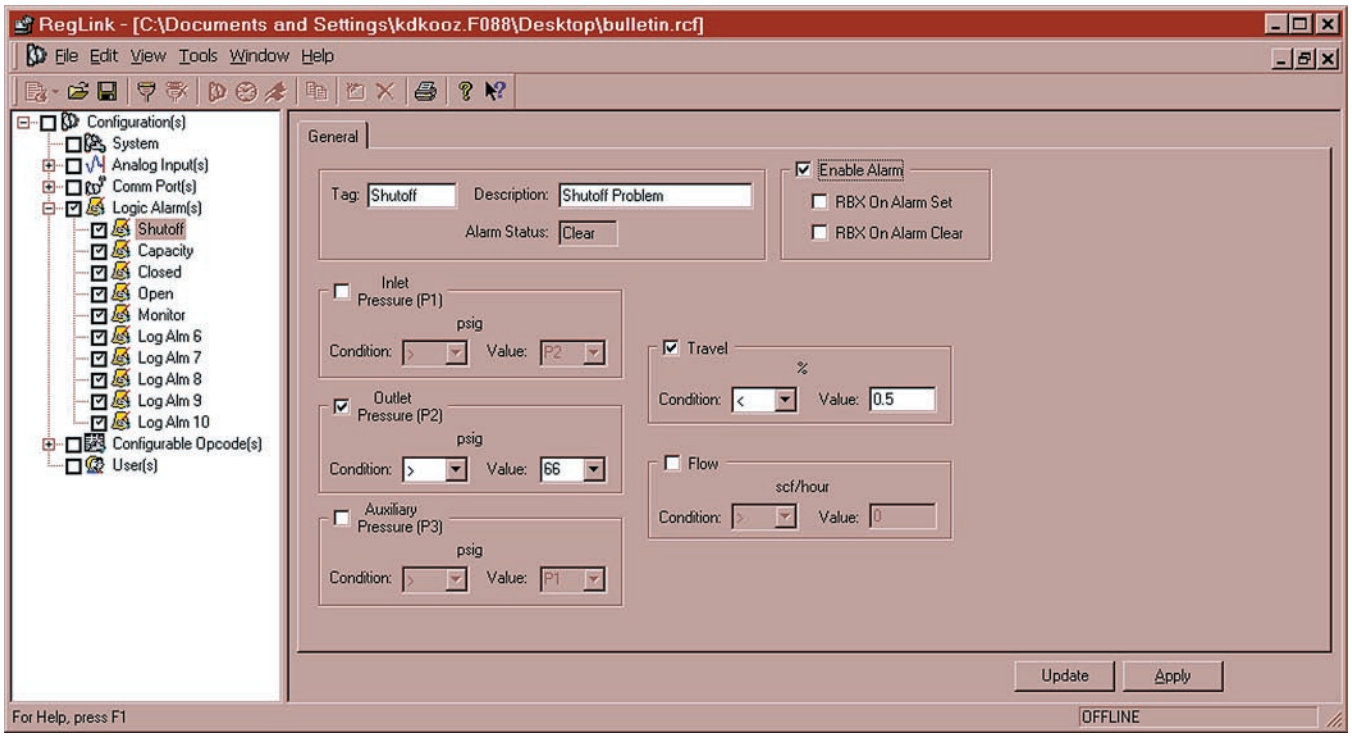


Figure 3. *Logic Alarms Display Screen*

Logic Alarms

Logic Alarms are used to set alarms that link multiple parameters and conditions together. Inlet pressure (P_1), Outlet pressure (P_2), auxiliary pressure (P_3), travel and flow are the available parameters. Conditions of greater than, less than, or not applicable may be set for each parameter to compare the parameter to an entered value. A default list of Logic Alarms is displayed if the appropriate Installation Type has been configured. Up to 10 different alarms may be configured per device.

Each Logic Alarm may also be set for RBX alarming. A record of the alarms is stored in the Alarm Log. The Alarm Log stores 240 of the latest alarms. The following is a description of the default alarms by installation type:

Single Cut or Downstream RegFlo Instrument (2 Sensors) Installation Type

Shutoff—Alarm is set when the travel of the regulator is less than or equal to zero (closed) and the outlet (P_2) pressure is above the lockup pressure of the regulator or station. It is set to acknowledge that the regulator is still allowing gas to pass through the orifice or pilot. User must input the appropriate lock up pressure.

Capacity—Alarm is set when the travel of the regulator is greater than zero (open) and the outlet (P_2) pressure is below the setpoint and offset of the regulator. It is set to acknowledge that the regulator is not satisfying the demand of the system. User must input the appropriate setpoint and offset pressure.

Closed—Alarm is set when the travel of the regulator is less than or equal to zero (closed) and the outlet (P_2) pressure is below setpoint and offset of the regulator. It is set to acknowledge that the regulator is in the closed position and not opening to satisfying the demand of the system. The user must input the appropriate set point and offset of the regulator.

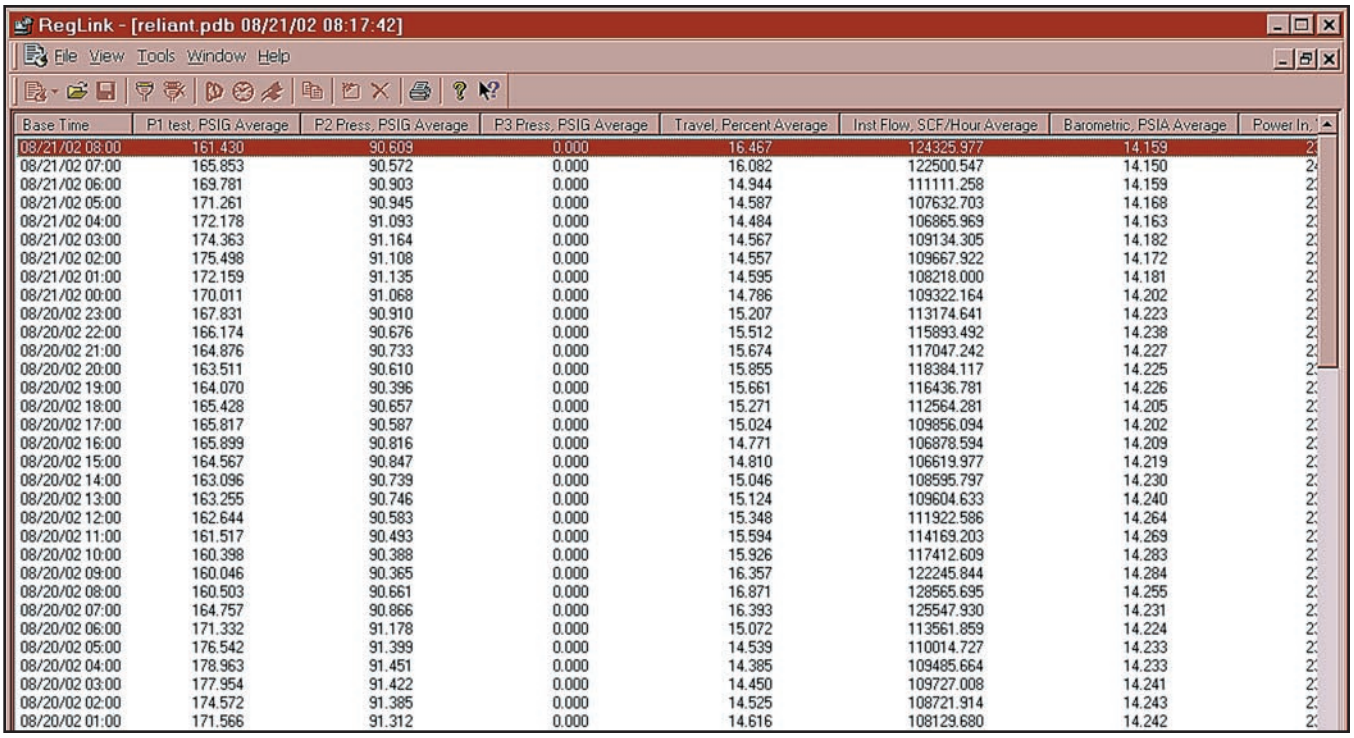
Open—Alarm is set when the travel of the regulator is greater than zero (open) and the outlet (P_2) pressure is above the lockup pressure of the regulator or station. It is set to acknowledge that the regulator is in the open position and not closing to respond to the decreased demand of the system. User must input the appropriate lock up pressure.

Downstream RegFlo Instrument (3 sensors) Installation Type

Shutoff—Same as the Downstream RegFlo Instrument (2 sensors) Installation Type

Capacity—Same as the Downstream RegFlo Instrument (2 sensors) Installation Type

Closed—Same as the Downstream RegFlo Instrument (2 sensors) Installation Type



Base Time	P1 test, PSIG Average	P2 Press, PSIG Average	P3 Press, PSIG Average	Travel, Percent Average	Inst Flow, SCF/Hour Average	Barometric, PSIA Average	Power In,
08/21/02 08:00	161.430	90.609	0.000	16.467	124325.977	14.159	2
08/21/02 07:00	165.853	90.572	0.000	16.082	122500.547	14.150	2
08/21/02 06:00	169.781	90.903	0.000	14.944	111111.258	14.159	2
08/21/02 05:00	171.261	90.945	0.000	14.587	107632.703	14.168	2
08/21/02 04:00	172.178	91.093	0.000	14.484	106865.969	14.163	2
08/21/02 03:00	174.363	91.164	0.000	14.567	109134.305	14.182	2
08/21/02 02:00	175.498	91.108	0.000	14.557	109667.922	14.172	2
08/21/02 01:00	172.159	91.135	0.000	14.595	108218.000	14.181	2
08/21/02 00:00	170.011	91.068	0.000	14.786	109322.164	14.202	2
08/20/02 23:00	167.831	90.910	0.000	15.207	113174.641	14.223	2
08/20/02 22:00	166.174	90.676	0.000	15.512	115893.492	14.238	2
08/20/02 21:00	164.876	90.733	0.000	15.674	117047.242	14.227	2
08/20/02 20:00	163.511	90.610	0.000	15.855	118384.117	14.225	2
08/20/02 19:00	164.070	90.396	0.000	15.661	116436.781	14.226	2
08/20/02 18:00	165.428	90.657	0.000	15.271	112564.281	14.205	2
08/20/02 17:00	165.817	90.587	0.000	15.024	109856.094	14.202	2
08/20/02 16:00	165.899	90.816	0.000	14.771	106878.594	14.209	2
08/20/02 15:00	164.567	90.847	0.000	14.810	106619.977	14.219	2
08/20/02 14:00	163.096	90.739	0.000	15.046	108595.797	14.230	2
08/20/02 13:00	163.255	90.746	0.000	15.124	109604.633	14.240	2
08/20/02 12:00	162.644	90.583	0.000	15.348	111922.586	14.264	2
08/20/02 11:00	161.517	90.493	0.000	15.594	114169.203	14.269	2
08/20/02 10:00	160.398	90.388	0.000	15.926	117412.609	14.283	2
08/20/02 09:00	160.046	90.365	0.000	16.357	122245.844	14.284	2
08/20/02 08:00	160.503	90.661	0.000	16.871	128565.695	14.255	2
08/20/02 07:00	164.757	90.866	0.000	16.393	125547.930	14.231	2
08/20/02 06:00	171.332	91.178	0.000	15.072	113561.859	14.224	2
08/20/02 05:00	176.542	91.399	0.000	14.539	110014.727	14.233	2
08/20/02 04:00	178.963	91.451	0.000	14.385	109485.664	14.233	2
08/20/02 03:00	177.954	91.422	0.000	14.450	109727.008	14.241	2
08/20/02 02:00	174.572	91.385	0.000	14.525	108721.914	14.243	2
08/20/02 01:00	171.566	91.312	0.000	14.616	108129.680	14.242	2

Figure 4. *History Log Display Screen*

Open—Same as the Downstream RegFlo Instrument (2 sensors) Installation Type

Monitor—Alarm is set when the travel of the regulator is greater than zero (open) and the RegFlo instrument inlet (P_1) pressure or station intermediate pressure is below the normal operating range. In addition the alarm is monitoring the station inlet pressure (P_3) to ensure that it is at or above the normal operating range. It is set to acknowledge that the station is being controlled by the Monitor regulator or pilot and that the worker has failed in the open position. User must input the appropriate normal operating pressures for station inlet and station intermediate.

Upstream RegFlo Instrument (3 sensors) Installation Type

Shutoff—Alarm is set when the travel of the regulator is less than or equal to zero (closed) and the auxiliary (P_3) pressure is above the lockup pressure of the regulator or station. It is set to acknowledge that the regulator is still allowing gas to pass through the orifice or pilot. User must input the appropriate lock up pressure.

Capacity—Alarm is set when the travel of the regulator is greater than zero (open) and the auxiliary (P_3) pressure is below the setpoint and offset of the regulator. It is set to acknowledge that the regulator is not satisfying the demand of the system. User must input the appropriate setpoint and offset pressure.

Closed—Alarm is set when the travel of the regulator is less than or equal to zero (closed) and the auxiliary (P_3) pressure is below setpoint and offset of the regulator. It is set to acknowledge that the regulator is in the closed position and not opening to satisfying the demand of the system. User must input the appropriate set point and offset of the regulator.

Open—Alarm is set when the travel of the regulator is greater than zero (open) and the auxiliary (P_3) pressure is above the lockup pressure of the regulator or station. It is set to acknowledge that the regulator is in the open position and not closing to respond to the decreased demand of the system. User must input the appropriate lock up pressure.

Monitor—Alarm is set when the travel of the regulator is greater than zero (open) and the RegFlo instrument outlet (P_2) pressure or station intermediate pressure is below the normal operating range. In addition, the alarm is monitoring the station inlet pressure (P_1) to ensure that it is at or above the normal operating range. It is set to acknowledge that the station is being controlled by the Monitor regulator or pilot and that the worker has failed in the open position. User must input the appropriate normal operating pressures for station inlet and station intermediate.

Table 5. *Battery Life Expectancy*

COMMUNICATIONS MODE	MONTHS OF BATTERY LIFE[1]						
	Sample Interval[2]						
	10 seconds	30 seconds	1 minute	2 minutes	5 minutes	10 minutes	30 minutes
Base Consumption[3]	9	22	35	49	66	74	81
Scheduled Auto Answer (30m)[4]	8	17	24	30	35	38	39
Scheduled Auto Answer (10m * 8hr)[5]	7	14	19	23	26	27	28
Scheduled Auto Answer (Full Time)[6]	2	3	3	3	3	3	3
Power up on Ring Modem[7]	8	19	27	35	43	46	49
Only RS232 Card[7]	8	20	30	40	50	54	58
Only RS485 Card[7]	8	17	24	29	35	37	38
Powered Modem and RS485 card[7]	7	14	19	23	26	27	28

1. Assumes usable battery capacity is 80 percent (allows for operating temperature and shelf life).
2. The battery should not be used with a 1 second sample interval.
3. Base Consumption assumes no Host communications and one connection (15 minute) with local RegLink once per week.
4. Scheduled Auto Answer (30m) assumes that modem is active for 30 minutes per day and has a 5 minute phone connection per day.
5. Scheduled Auto Answer (10m * 8 hr) assumes that the modem is active for 80 minutes per day and has a 5 minute phone connection per day.
6. Scheduled Auto Answer (Full Time) assumes that the modem is active all of the time to receive a communication.
7. Assumes a 5 minute connection per day.

Table 6. *Average Current Draw*

COMMUNICATIONS MODE	AVERAGE CURRENT DRAW (mA)[1]							
	Sample Interval							
	1 second	10 seconds	30 seconds	1 minute	2 minutes	5 minutes	10 minutes	30 minutes
Base Consumption[2]	11.779	1.426	0.659	0.468	0.372	0.314	0.295	0.282
Scheduled Auto Answer (30m)[3]	11.974	1.621	0.854	0.663	0.567	0.509	0.490	0.477
Scheduled Auto Answer (10m * 8hr)[4]	12.182	1.829	1.062	0.871	0.775	0.717	0.698	0.685
Scheduled Auto Answer (Full Time)[5]	17.579	7.226	6.459	6.268	6.172	6.114	6.095	6.082
Power up on Ring Modem[6]	11.883	1.530	0.763	0.572	0.476	0.418	0.399	0.386
Only RS232 Card[6]	11.881	1.528	0.761	0.570	0.474	0.416	0.397	0.384
Only RS485 Card[6]	12.107	1.754	0.987	0.796	0.700	0.642	0.623	0.610
Powered Modem and RS485 card[6]	12.178	1.834	1.067	0.876	0.780	0.722	0.703	0.690

1. Average Current Draw when device is externally powered.
2. Base Consumption assumes no Host communications and one connection (15 minute) with local RegLink once per week.
3. Scheduled Auto Answer (30m) assumes that modem is active for 30 minutes per day and has a 5 minute phone connection per day.
4. Scheduled Auto Answer (10m * 8 hr) assumes that the modem is active for 80 minutes per day and has a 5 minute phone connection per day.
5. Scheduled Auto Answer (Full Time) assumes that the modem is active all of the time to receive a communication.
6. Assumes a 5 minute connection per day.

History Log

Data is recorded and stored in the History Log. The user can view this file from an on-line device or from a disk file with RegLink software. History files may be converted to common spreadsheet and database formats. There are three types of History files in the RF100 Series. One file is used to store the points on a daily basis. The daily history file stores 35 days of data.

The Periodic file, the second type of history file, is used to store the points for the log interval selected in the System screen. The Periodic file stores 840 of the latest records.

Minimum and maximum values are stored in the same History file as the other points. A minimum and maximum value for specific parameters is recorded for each base time record.

20 History Points for Periodic and daily frequencies:

- Base time
- P_1 Average
- P_2 Average
- P_3 Average
- Travel Average
- Instantaneous Flow Average
- Barometric Pressure
- Input Voltage
- Logic (Battery) Voltage
- Board Temperature
- Accumulated Flow
- Travel Accumulated
- P_1 Minimum
- P_1 Maximum
- P_2 Minimum
- P_2 Maximum
- P_3 Minimum
- P_3 Maximum
- Instantaneous Flow Minimum
- Instantaneous Flow Maximum

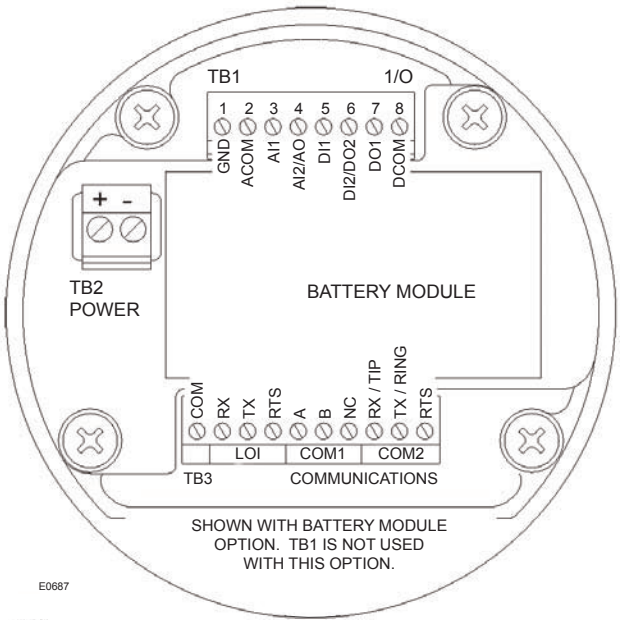

TB1
1/O
1 2 3 4 5 6 7 8
GND ACOM AI1 AI2/AO DI1 DI2/DO2 DO1 DCOM
+ -
TB2
POWER
BATTERY MODULE
COM RX TX RTS A B NC RX / TIP TX / RING RTS
LOI COM1 COM2
TB3
COMMUNICATIONS
SHOWN WITH BATTERY MODULE OPTION. TB1 IS NOT USED WITH THIS OPTION.
E0687

Figure 5. *Wiring Label*

The third type of History file is the Extended History file. This file stores 8640 logs of nine history points. This is equivalent to 30 days of five minute increments. Initially, the nine points will be defined as the minimum, maximum, and average of the three pressure sensors. In the future, these points will be definable by the user.

Solar Panel and Battery Sizing Example

The two important elements in a solar installation are solar panels and batteries. Solar panels and batteries must be properly sized for the application and geographic location to ensure continuous, reliable operation. To determine solar panel output requirements, first determine the Average Current Draw for the devices being powered and the solar insolation for your geographic area. Average current draw can be found in Table 6. The example uses the Average Current Draw for a 1 minute sample interval, the Scheduled Auto Answer modem available for communications full time and 1.5 hours of insolation. Calculate the amount of current (I_{array}) required from the solar array per day using the following equation.

I_{array} = [Average Current Draw (6.268 mA) x 24 (hrs)] ÷ 1.5 hrs of Insolation = 100.3 mA

Convert this value to amps by dividing by 1000 (1 amp is equal to 1000mA).

I_{array} = 100.3 mA ÷ 1000 = 0.1003 amps

Finally, the output current of the panel (I_{panel}) is used to calculate the number of solar panels required using the following equation:

Number of Panels = I_{array} amps ÷ (I_{panel} amps/panel) = _____ panels

For our example, if I_{array} equals 0.1003 amps, and I_{panel} equals 0.29 amps for a 5-watt panel (typical), then the number of panels required equals 0.35, which would be rounded up to 1. The "I_{panel}" value varies depending on the type of solar panel installed. Refer to the vendor's specifications for the solar panel being used.

Batteries are used to supplement both line-powered and solar-powered installations. When used in line-powered installations, the batteries serve as backup in case of line power failure. When used in solar installations, they provide power for the instrument when the solar panels are not generating sufficient output.

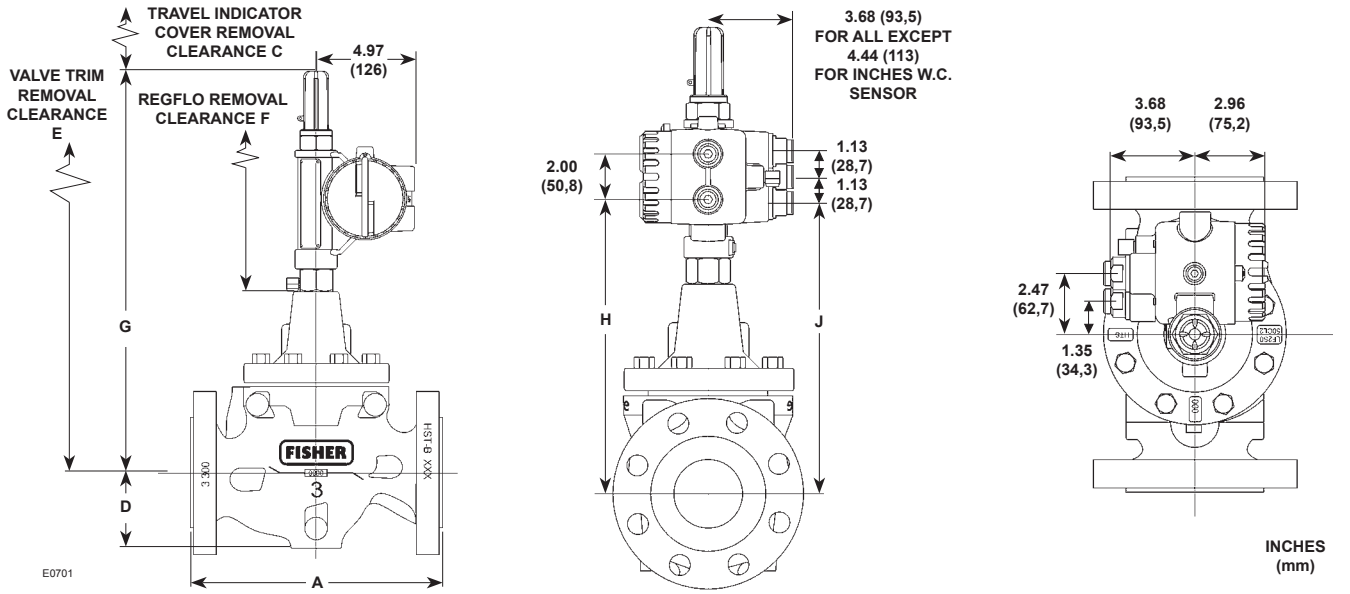
Typical battery configurations use a 12-volt, sealed, lead-acid battery. These configurations typically provide 7 amp-hours of capacity. Batteries can be connected in parallel to achieve more current capacity. The amount of battery capacity required for a particular installation depends upon the power requirements of the equipment and days of reserve (autonomy) desired.

Battery reserve is the amount of time that the batteries can provide power without discharging below 20 percent of their total output capacity. For solar-powered units, a minimum reserve of five days is recommended, with ten days of reserve preferred. Add 24 hours of reserve capacity to allow for overnight discharge.

To determine the battery capacity requirements, multiply the Average Current Draw by the amount of reserve time required. The Average Current Draw is shown in Table 6. The value is shown in mA and needs to be converted to amps for use in the following equation:

System Requirement = Average Current Draw (amps) x Reserve hrs = _____ amp-hrs

Continuing with our example. The Average Current Draw would be 0.006268 amps. Using 11 days (264 hours) of reserve capacity, the system requirement would be 1.7 amp-hrs. In this case, a battery with any more than 1.7 amp-hours would meet the requirements.



TYPE RF100 MOUNTED ON TYPE EZR											
Body Size, Inches (mm)	Dimensions, Inches (mm)										
	A				C	D	E	F	G	H	J
	SWE or NPT	125B FF or 150 RF	250B or 300 RF	600 RF or BWE							
1 (25)	8.3 (211)	7.3 (185)	7.75 (197)	8.3 (211)	2.7 (68,6)	2.4 (61,0)	19.2 (488)	14.2 (361)	17.2 (437)	9.7 (246)	9.6 (244)
2 (50)	11.3 (287)	10.0 (254)	10.5 (267)	11.3 (287)	2.00 (50,8)	3.06 (77,7)	19.19 (487)	14.2 (361)	17.19 (437)	9.73 (247)	9.61 (244)
3 (80)	- - - -	11.8 (300)	12.5 (317)	13.3 (338)	3.8 (96,5)	3.8 (96,5)	27.8 (706)	17.2 (437)	21.8 (554)	14.3 (363)	14.2 (361)
4 (100)	- - - -	13.9 (353)	14.5 (368)	15.5 (394)	3.75 (95,2)	5.06 (129)	28.9 (734)	17.2 (437)	22.9 (582)	15.44 (392)	15.32 (389)
6 (150)	- - - -	17.8 (452)	18.6 (472)	20 (508)	3.8 (96,5)	5.5 (140)	29.4 (747)	18.4 (467)	27.9 (709)	16.7 (424)	15.5 (394)

TYPE RF100 MOUNTED ON TYPE 1098-EGR											
Body Size, Inches (mm)	Dimensions, Inches (mm)										
	A				C	D	E	F	G	H	J
	SWE or NPT	125B FF or 150 RF	250B or 300 RF	600 RF or BWE							
1 (25)	8.3 (211)	7.3 (185)	7.75 (197)	8.3 (211)	4.1 (104)	3.9 (99,1)	19.6 (498)	17.0 (432)	19.2 (488)	8.7 (221)	7.5 (191)
2 (50)	11.3 (287)	10.0 (254)	10.5 (267)	11.3 (287)	4.1 (104)	4.6 (117)	20.2 (513)	17.0 (432)	19.8 (503)	9.3 (236)	8.1 (206)
3 (80)	- - - -	11.8 (300)	12.5 (317)	13.3 (338)	5.1 (130)	5.3 (135)	24 (610)	18.2 (462)	22.2 (564)	11.3 (287)	10.0 (254)
4 (100)	- - - -	13.9 (353)	14.5 (368)	15.5 (394)	5.1 (130)	6.6 (168)	26.7 (678)	19.9 (505)	24.1 (612)	12.8 (325)	11.6 (295)
6 (150)	- - - -	17.8 (452)	18.6 (472)	20 (508)	8.0 (203)	8.1 (206)	27.7 (704)	19.8 (503)	24.7 (627)	13.4 (340)	12.2 (310)

Figure 6. *Type RF100 Dimensions*

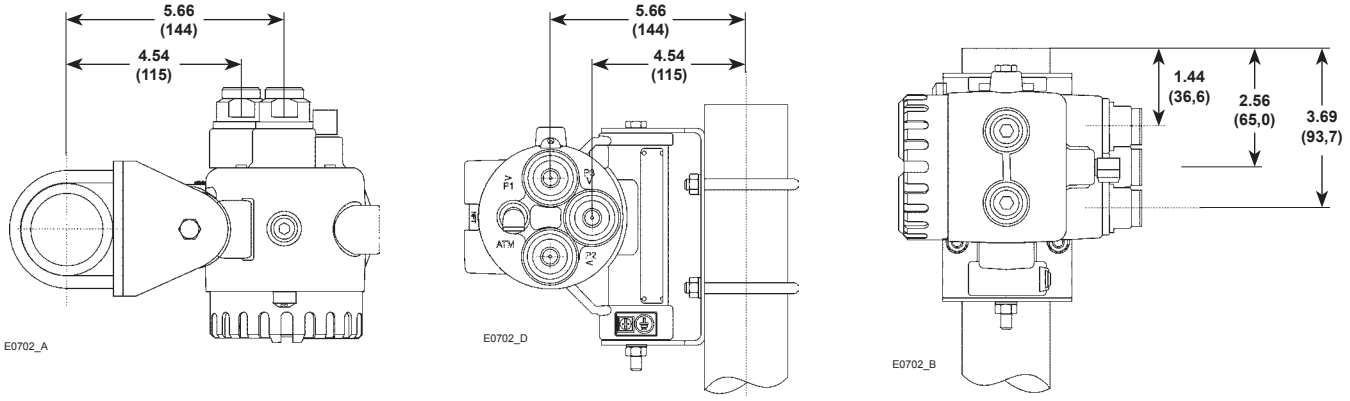
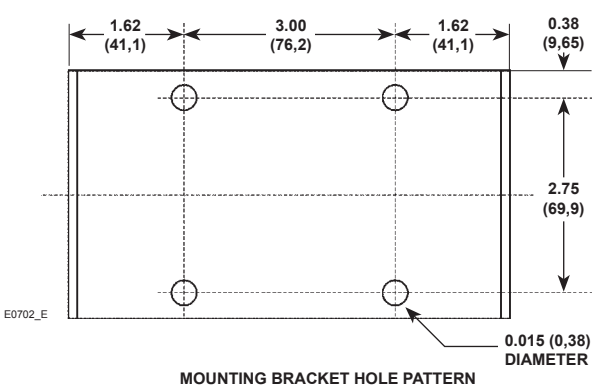


Figure 7. *Type RF110 Dimensions*



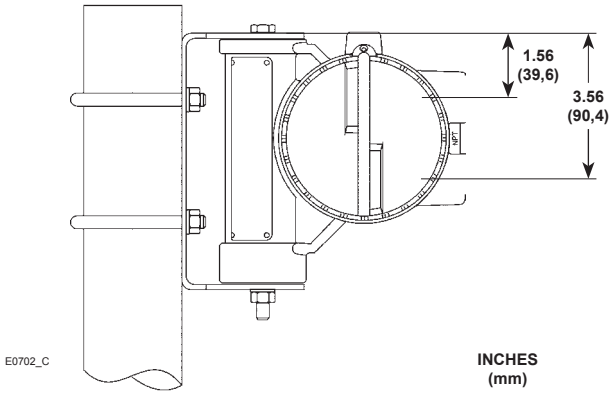


Figure 7. *Type RF110 Dimensions (continued)*

Ordering Guide

RegFlo Type RF110 Pressure Instrument

Battery Module (Select)

☐ Yes

P_1 Inlet Pressure Sensor (Select One)

☐ 0 to 1000 psig (0 to 68,9 bar)
☐ 0 to 500 psig (0 to 34,5 bar)
☐ 0 to 300 psig (0 to 20,7 bar)
☐ 0 to 100 psig (0 to 6,90 bar)
☐ 0 to 35 psig (0 to 2,41 bar)
☐ 0 to 15 psig (0 to 1,03 bar)
☐ 0 to 30-inches w.c. (0 to 75 mbar)

P_2 Outlet Pressure Sensor (Select One)

☐ None
☐ 0 to 1000 psig (0 to 68,9 bar)
☐ 0 to 500 psig (0 to 34,5 bar)
☐ 0 to 300 psig (0 to 20,7 bar)
☐ 0 to 100 psig (0 to 6,90 bar)
☐ 0 to 35 psig (0 to 2,41 bar)
☐ 0 to 15 psig (0 to 1,03 bar)
☐ 0 to 30-inches w.c. (0 to 75 mbar)

P_3 Auxiliary Pressure Sensor (Select One)

☐ None
☐ 0 to 1000 psig (0 to 68,9 bar)
☐ 0 to 500 psig (0 to 34,5 bar)
☐ 0 to 300 psig (0 to 20,7 bar)
☐ 0 to 100 psig (0 to 6,90 bar)
☐ 0 to 35 psig (0 to 2,41 bar)
☐ 0 to 15 psig (0 to 1,03 bar)
☐ 0 to 30-inches w.c. (0 to 75 mbar)

Communication Card (Select One)

☐ None
☐ Dial up modem
☐ RS-232

RegFlo Accessories

RegLink Configuration Software (Select)

☐ Yes

Operator Interface Cable (Select)

☐ Yes

RegFlo Type RF100 Flow and Pressure Instrument

(Type RF100 may be ordered mounted on a Type EZR or 1098-EGR or as a retrofit to an existing unit.)

Type and Body Size (Select One)

Type EZR

☐ 1-inch (DN 25)
☐ 2-inch (DN 50)
☐ 3-inch (DN 80)
☐ 4-inch (DN 100)
☐ 6-inch (DN 150)

Type 1098-EGR

☐ 1-inch (DN 25)
☐ 2-inch (DN 50)
☐ 3-inch (DN 80)
☐ 4-inch (DN 100)
☐ 6-inch (DN 150)

Battery Module (Select)

☐ Yes

P_1 Inlet pressure sensor (Select One)

☐ 0 to 1000 psig (0 to 68,9 bar)
☐ 0 to 500 psig (0 to 34,5 bar)
☐ 0 to 300 psig (0 to 20,7 bar)
☐ 0 to 100 psig (0 to 6,90 bar)
☐ 0 to 35 psig (0 to 2,41 bar)
☐ 0 to 15 psig (0 to 1,03 bar)
☐ 0 to 30-inches w.c. (0 to 75 mbar)

P_2 Outlet pressure sensor (Select One)

☐ 0 to 1000 psig (0 to 68,9 bar)
☐ 0 to 500 psig (0 to 34,5 bar)
☐ 0 to 300 psig (0 to 20,7 bar)
☐ 0 to 100 psig (0 to 6,90 bar)
☐ 0 to 35 psig (0 to 2,41 bar)
☐ 0 to 15 psig (0 to 1,03 bar)
☐ 0 to 30-inches w.c. (0 to 75 mbar)

P_3 Auxiliary pressure sensor (Select One)

☐ None
☐ 0 to 1000 psig (0 to 68,9 bar)
☐ 0 to 500 psig (0 to 34,5 bar)
☐ 0 to 300 psig (0 to 20,7 bar)
☐ 0 to 100 psig (0 to 6,90 bar)
☐ 0 to 35 psig (0 to 2,41 bar)
☐ 0 to 15 psig (0 to 1,03 bar)
☐ 0 to 30-inches w.c. (0 to 75 mbar)

Ordering Guide (continued)

RTD Interface Metre
- ☐ Yes

Communication Card (Select One)
- ☐ None
- ☐ Dial up modem
- ☐ RS-232

Type EZR Information (for retrofit)

Cage, Percent of Full Capacity (Select One)
- ☐ 100% (standard)
- ☐ 60%
- ☐ 30%

Main Valve Spring (Select One)
- ☐ White [1-inch (DN 25) only]
- ☐ Light Blue [1 or 3-inch (DN 25 or 80) only]
- ☐ Black [1 or 3-inch (DN 25 or 80) only]
- ☐ Yellow [2, 3, or 6-inch (DN 50, 80, or 150) only]
- ☐ Green [2, 4, or 6-inch (DN 50, 100, or 150) only]
- ☐ Red [2, 4, or 6-inch (DN 50, 100, or 150) only]

Main Valve Diaphragm Material (Select One)
- ☐ 17E97 Nitrile (standard)
- ☐ 17E67 Nitrile
- ☐ 17E68 Low Temperature Nitrile
- ☐ 17E88 Fluoroelastomer (FKM)

Type 1098-EGR information (for retrofit)

Cage Type (Select One)
- ☐ Linear
- ☐ Quick Opening
- ☐ Whisper

Cage, Percent of Full Capacity (Select One)

1-inch (DN 25)
- ☐ 100%

2-inch (DN 50)
- ☐ 100%
- ☐ 70%
- ☐ 30%

3, 4, or 6-inch (DN 80, 100, or 150)
- ☐ 100% (standard)
- ☐ 60%

Main Valve Spring (Select One)
- ☐ Green
- ☐ Blue
- ☐ Red
- ☐ Yellow

RegFlo Accessories

RegLink Configuration Software (Select)
- ☐ Yes

Operator Interface Cable (Select)
- ☐ Yes

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Outside U.S. 1-469-293-4201

Asia-Pacific
Shanghai, China 201206
Tel: 86-21-5899 7887

Europe
Bologna, Italy 40013
Tel: 39 051 4190611

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McKinney, Texas 75050
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Outside U.S. 1-469-293-4201

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Selmsdorf, Germany 23923
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